

Amendments to the Specification:

Please add the following new paragraphs after the title on page 1, line 5:

DESCRIPTION

FIELD OF INVENTION

Please replace the paragraph beginning at page 1, line 6 which starts "The present invention relates" with the following amended paragraph:

The present invention relates to optical fibers and in particular to the manufacturing of an optical fiber with a decoupling interface for scattered light and to the measuring of the optical power guided through said optical fiber. A method for manufacturing of an optical fiber with a decoupling interface for scattered light and a use of an optical fiber as well as a device for monitoring of the light power guided through said optical fiber are presented. The use of the optical fiber for monitoring is especially applicable for controlling the light power of a light source or alternatively for controlling the mechanism of ~~in-~~coupling coupled light from the light source into the optical fiber.

Please add the following new paragraph before the paragraph beginning on page 1, line 19:

BACKGROUND OF THE INVENTION

Please replace the paragraph beginning at page 3, line 1 which starts "Throughout the following" with the following amended paragraph:

Throughout the following, the term "laser-active optical fiber" shall be understood as an optical fiber having the core

doped with a laser-active material, for example with a rare earth composition. Absorption of optical energy (so called "pump light") ~~in-coupled~~ coupled into the optical fiber leads to a population inversion of the energy levels of the doping material in the core of the fiber, so that light amplification results for one wavelength or for several wavelengths. Laser-active optical fibers can be operated both as fiber lasers or fiber amplifiers.

Please replace the paragraph beginning on page 3, line 33 which starts "In this respect" with the following amended paragraph:

In this respect, ~~{1}~~ US 4,398,795 and ~~{2}~~ EP 0619506 describe how the guided light can be tapped by fixing of an optical fiber and cutting into or polishing the fiber cladding. In ~~{3}~~ EP 1014131 the use of a connecting piece made of light guiding material is taught, which connecting piece removes the coating and the cladding of an optical fiber so that the fiber core is uncovered and light can be ~~in-coupled~~ coupled into the connecting piece.

Please replace the paragraph beginning on page 4, line 7 which starts "In [4] is described" with the following amended paragraph:

In ~~{4}~~ EP 1008876 is described a method for extracting light out of an optical fiber, wherein the optical fiber is impressed and deformed. For example, a wedge can be pressed onto the fiber for this. Due to the deformation, reflecting surfaces can be created in the optical fiber, which reflecting surfaces reflect a part of the light to a suitably positioned detector.

Please replace the paragraph beginning on page 4, line 15 which starts "According to [5]" with the following amended paragraph:

According to {5} US 4,781,428, a periodic spatial deformation of an optical fiber can be used in order to tap light out of the optical fiber. For this, the optical fiber can, for example, be pressed against a solid grid-like structure. At certain optical frequencies which are determined by the period of the grid mode-mixing is achieved, such as between core modes and cladding modes of the optical fiber. The cladding modes can be tapped out of the optical fiber. The intensity of the decoupled light can be varied by varying the strength of the contact pressure.

Please replace the paragraph beginning on page 4, line 30 which starts "In [6] a tapping device" with the following amended paragraph:

In {6} US 4,887,879 a tapping device is described, wherein at first cladding modes are induced in an optical fiber, which cladding modes are subsequently detected at a tapered position of the optical fiber. The tapering is produced, for example, by chemically etching away a part of the fiber cladding after removal of the cladding.

Please replace the paragraph beginning on page 5, line 17 which begins "A second group of methods" with the following amended paragraph:

A second group of methods employs a sufficiently tight bending of an optical fiber in order to extract a part of the light power. An example of one such "bending coupler" is described in {7} US 3,936,631. A device for monitoring the light power guided within an optical fiber is demonstrated in {8} US 5,080,506 wherein at first the modes propagating in the cladding are removed by applying a so called "mode stripper", i.e. a material with a refractive index equal to or greater than that of the cladding. Subsequently, a part of the guided light power is coupled out by a bending coupler.

Please replace the paragraph that begins on page 5, line 28 which begins "In [9] a battery driven" with the following amended paragraph:

In ~~{9}~~ US 5,591,964 a battery driven or solar cell driven device for measuring the power guided within an optical fiber is described, wherein a part of the light power is removed from the optical fiber by applying a "micro-bend". Such a micro-bend is produced by tightly bending the optical fiber at some position with a bending radius of preferably < 2 mm, in doing so the temperature of the optical fiber is raised above the melting point for a short period of time due to a local heating. After cooling down, the micro-bend is mechanically fixed to the optical fiber. The micro-bend at the optical fiber leads to the effect that light rays reaching the core of the optical fiber in the region of the micro-bend are incident upon the interface surface between the core and the cladding of the optical fiber at an angle of α_2 being smaller than the critical angle α_c of total reflection, i.e. $\alpha_2 < \alpha_c$ is fulfilled (α_2 and α_c are taken relative to the surface normal of the interface surface). Therefore, in the region of the micro-bend the light rays are not totally reflected, but are partially decoupled out of the optical fiber through the cladding.

Please replace the paragraph that begins on page 6, line 15 which begins "One disadvantage of such device" with the following amended paragraph:

One disadvantage of such devices is the difficult reproducibility of the decoupled intensity, because the portion of decoupled power depends on the structure and composition of the respective optical fiber. In addition, the danger of a break of the fiber exists, unless laborious measures are taken to avoid it (~~{10}~~ US 5,039,188 describes a bending coupler with devices which apply compression pressure to an optical fiber in a suitable way, in order to reduce the risk of a break of the fiber). The

extensive spatial distribution of the light radiated out presents another disadvantage of such devices. It is therefore difficult to collect this light on a small photo detector which affects the applicability of such couplers for fast controls.

Please replace the paragraph that begins on page 6, line 29 which begins "Thermally manufactured micro-bends" with the following amended paragraph:

Thermally manufactured micro-bends, as shown in {9} US 5,591,964, ~~besides the~~ are critically mechanically stability stable comprise the and additionally include a manufacturing challenge [[that]] because at least two parameters (temperature and bending radius) have to be monitored during manufacturing. This increases the risk of damaging the optical fiber, for example as a result of a too high or too long influence of temperature.

Please replace the paragraph that begins on page 7, line 4 which begins "In another group of methods" with the following amended paragraph:

In another group of methods, the fiber is severed in order to tap a part of the light power. In {11} US 4,165,496 is described a beam splitter which is realized by exactly coaxial aligning two fiber pieces with skew beveled end surfaces being parallel to each other. At the end surfaces, light is reflected out of the optical fiber. This method, however, requires an extremely precise and therefore laborious adjustment. In addition, there is the risk that mechanical agitations cause an offset of the fiber pieces, thereby disconnecting the light guide.

Please replace the paragraph that begins on page 7, line 15 which begins "Advancements in this idea" with the following amended paragraph:

Advancements of this idea include the production of joint positions by splicing of fiber pieces. In {12} US 4,475,789 a

fiber-optic power monitor is demonstrated, wherein two optical fibers having different mode volumes are spliced together. Thereby, the mode volume of the second optical fiber is smaller than that of the first optical fiber, such that a part of the light guided through the first optical fiber cannot propagate through the second optical fiber. The scattered light resulting at the splice position is detected and serves as control signal for a power control.

Please replace the paragraph that begins on page 7, line 26 which begins "The method described in [11]" with the following amended paragraph:

The method described in ~~{11}~~ US 4,165,496 requires optical fibers with different mode volumes, for example optical fibers with different refractive index profiles are applied. However, in case of single-mode waveguides - in particular for less common wavelengths - suitable optical fibers with different refractive index geometry are difficult to obtain, if at all. This method is further disadvantageous for the use of multi-mode waveguides when the ray profile or the transverse mode structure, respectively, of the light source changes, for example due to power variations of a laser light source or due to a mechanical impact onto the optical fiber (for example as a result of touching). In this case, the ratio of the light power guided in the two optical fibers may change. This method is therefore susceptible for errors concerning its ability to measure the power guided in the second optical fiber.

Please replace the paragraph that begins on page 8, line 9 which begins "In [12] a method is taught" with the following amended paragraph:

In ~~{12}~~ US 4,475,789 a method is taught, wherein an optical fiber is severed, and one of the resulting end surfaces is coated within a vacuum apparatus with dielectric material (e.g. TiO_2) or a

metal (e.g. Ti). Subsequently, the fiber pieces are spliced with each other again. While doing so, electric arcs are applied until a desired reflectivity is obtained at the connection position.

Please replace the paragraph that begins on page 9, line 1 which begins "Furthermore, other methods apply doping" with the following amended paragraph:

Furthermore, other methods apply doping of the optical fiber with extrinsic atoms or particles in order to decouple a part of the light by reflection or refraction. According to ~~{13}~~ US 4,923,273, scattered light can be generated by utilizing means (e.g. chemical admixtures) incorporated into the optical fiber, which means modify one or more fiber parameters. This publication refers in particular to "activatable means", for example extrinsic atoms evoking a change of refractive index (or another fiber parameter) due to the impact of electromagnetic radiation, due to heat, or due to bombardment with electrons or ions.

Please replace the paragraph that begins on page 9, line 20 which begins "The application of light scattering" with the following amended paragraph:

The application of light scattering or light refracting particles in the core of a light guide is described in ~~{14}~~ US 4,618,211. If the particles are incorporated during the manufacturing of the fiber, the optical fiber emits scattered light along its whole length. Alternatively, at first the fiber core is formed which is treated by means of heat or radiation in order to generate light deflecting defects. Or the optical fiber is irradiated by ionizing radiation or laser light after completion, thereby provoking microscopic deficiencies in the structure of the fiber core.

Please replace the paragraph that begins on page 10, line 6 which begins "In [15] an optical fiber is described" with the following amended paragraph:

In ~~{15}~~ US 4,466,697 an optical fiber is described, whose core is interspersed with light scattering particles as scatter centers. These light scattering particles can be incorporated into the core by admixing adequate material in the melt from which the core of the optical fiber is drawn, and by spraying adequate material onto the core, before creation of the cladding.

Please replace the paragraph that begins on page 10, line 14 which begins "A device and method to monitor the light" with the following amended paragraph:

A device and a method to monitor the light guided through an optical fiber are known from ~~{16}~~ DE 4313795. Therein an optical fiber is enveloped by a glass tube in the vicinity of a joint position (but not at the joint position itself). This glass tube is filled with an adhesive and guides scattered light to a detector, which scattered light is radiated out of the core of the optical fiber into the cladding at the joint position and is transferred from there into the glass tube.

Please replace the paragraph that begins on page 10, line 23 which begins "From [17] a means for monitoring" with the following amended paragraph:

From ~~{17}~~ DE 4314031 a means for monitoring and protecting optical waveguide (OWG) cables is known, said means detecting energy leakage on account of a malfunction out of an OWG cable or an OWG fiber. The damage of the OWG cable occurs due to uncontrolled decoupling of the laser rays at defects of the OWG cable, for example based on a minor case of falling below the allowed bending radius.

Please replace the paragraph that begins on page 10, line 31 which begins "A method for monitoring a splicing process" with the following amended paragraph:

A method for monitoring a splicing process when splicing two optical fibers to each other is described in ~~{18}~~ JP 55035350. Shortly prior to the splicing operation, light is transmitted through the two optical fibers. The scattered light emanating at the position to be spliced is detected by a detector and the two optical fibers are adjusted relative to each other such that the detector does not detect scattered light any more. In this way, an optimal adjusting of the two optical fibers relative to each other is obtained, i.e. the two optical fibers are spliced to each other only if an optimal transmission of light through the two optical fibers has been reached.

Please replace the paragraph that begins on page 11, line 10 which begins "In [19] a spatially quantitative light detector is disclosed" with the following amended paragraph:

In ~~{19}~~ US 4,371,897 a spatially quantitative light detector is disclosed comprising an optical fiber and a photo sensor coupled to the optical fiber. The core of the optical fiber is interspersed by a fluorescing substance. Light incident upon the surface of the optical fiber is guided through the optical fiber to the photo sensor and is detected there by the photo sensor.

Please add the following new paragraph before the paragraph beginning on page 11, line 17:

SUMMARY OF THE INVENTION

Please replace the paragraph that begins on page 13, line 18 which begins "The principle of the invention is" with the following amended paragraph:

The principle of the invention is, illustratively, that at an intermediate position an optical fiber is modified in its structure by means of an electro-thermal treatment, said optical fiber being substantially straightly aligned at said intermediate position, i.e. a partial mixture of core material and cladding material in said interface region between said core and said cladding is effected, such that scattered light emanates out of said optical fiber at the at least one intermediate position. Said partial mixture of core material and cladding material in said interface region between said core and said cladding effects the insertion of isolated scattering centers for incoming light rays into the peripheral region of said core, which scattering centers deflect the direction of incident light rays in such a way, that these are incident upon said interface layer at an angle α_2 . This angle α_2 is smaller than said critical angle α_c of total reflection only for said light rays scattered at said scattering centers, i.e. it is $\alpha_2 < \alpha_c$ fulfilled (α_2 and α_c refer to the surface normal of said interface layer). Therefore, said light rays deflected at said scattering centers are not totally reflected, but are decoupled from said optical fiber via said interface layer and said cladding. A part of the light ~~in-coupled~~ coupled into said optical fiber is therefore not guided further through said optical fiber, but emanates out of said optical fiber as scattered light. Said scattered light can be detected by a detector and, then, can give a measurement value for the light power guided through said optical fiber.

Please replace the paragraph that begins on page 15, line 8 which begins "Said electro-thermal treatment of said" with the following amended paragraph:

Said electro-thermal treatment of said intermediate position may be carried out by a single electric arc. It is also possible, however, to apply several successive electric arcs with time intervals between each other. In the latter case, the intensity of

said electric arcs may in particular vary, i.e. primarily the temporal duration of said individual electric arcs may be varied, thereby a varying power may be ~~in-coupled~~ coupled into said intermediate position to be treated.

Please replace the paragraph that begins on page 16, line 30 which begins "Light from a light source is transmitted" with the following amended paragraph:

Light from a light source is transmitted through said optical fiber. Said scattered light emitted out of said optical fiber and detected by said detector is subsequently preferably used to control the power of said light source and/or to control the ~~in-coupling~~ coupling efficiency of said light from said light source into said optical fiber. Illustratively, the measured signal of said detector is calibrated with respect to the output power, and said signal can subsequently serve as actual-value of a control loop regulating the power of said light source in-coupled into said optical fiber or regulating the mechanism of in-coupling of said light source into said optical fiber.

Please add the following new paragraph before the paragraph beginning on page 17, line 22:

BRIEF DESCRIPTION OF THE DRAWINGS

Please add the following new paragraph before the paragraph beginning on page 18, line 17:

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

Please replace the paragraph that begins on page 19, line 31 which begins "Since the extension of the decoupling interface" with the following amended paragraph:

Since the extension of the decoupling interface 200 along the fiber axis (i.e. perpendicular to the drawing plane of Fig.2a) is at most [some] a few mm, the transmission of light through the optical fiber occurs by total reflection. At the decoupling interface 200, though, the partially mixed material of the core 201 and the cladding 202 in the interface region 203 provides scattering centers (not shown). These scattering centers scatter light transmitted through the optical fiber in the peripheral region of the core 201 in a way, that this light is incident upon the interface layer 203 between the core 201 and the cladding 202 with an angle α_2 being smaller than the critical angle α_c of total reflection, i.e. $\alpha_2 < \alpha_c$ is fulfilled. There, the light is therefore partially transmitted through the interface layer 203 and the cladding 202 (α_2 and α_c refer to the surface normal of the interface layer 203).

Please replace the paragraph that begins on page 21, line 16 which begins "At least one electric arc" with the following amended paragraph:

At least one electric arc is ignited between the two electrode tips of the splicing device, a voltage of 12 kV being applied to the electrodes for each electric arc, and a current of ~~13...14~~ 13 to 14 mA is assigned to each electric arc for a duration of ~~0.5...2~~ 0.5 to 2 s, in particular of 1 s. Thereby, a temperature of 3,500°C to about 4,500°C is reached in the electric arc, which is substantially higher than the melting temperature of quartz being in the range between 1,700°C and 1,800°C.

Please replace the paragraph that begins on page 21, line 26 which begins "Each electric arc has a diameter" with the following amended paragraph:

Each electric arc has a diameter of about ~~1...2~~ 1 to 2 mm. Since the optical fiber has a diameter of 250 μm at the intermediate position, each electric arc encloses the optical

fiber at the intermediate position. Along the fiber axis of the optical fiber, the optical fiber is therefore partially melted at its periphery at a length of ~~1...2~~ 1 to 2 mm (according to the diameter of the arc), resulting in a partial mixture of cladding material and core material. For that, the temporal duration of each electric arc is adjusted in such a way, that cladding material can hardly enter the core, i.e. the damping of the power of light passing the resulting decoupling interface through the optical fiber is very small. In order to adjust a desired damping, several similar electric arcs are therefore successively applied with time intervals between each other (i.e. pulsed) to the same intermediate position to be treated of the optical fiber. According to the present invention, from three to seven inclusive, in particular from four to five inclusive, electric arcs are successively applied.

Please replace the paragraph that begins on page 23, line 25 which begins "For example, the application of further electric discharge" with the following amended paragraph:

For example, the application of further electric discharge arcs is suitable for the modification, whereby a partial mixture of the materials of the core and the cladding in a peripheral region of the core is obtained, so that scattered light appears at the treated position. Preferably, the light power transmitted through the optical fiber is monitored during the electric arc treatment, and the electric arc treatment is continued until a desired damping of the light power transmitted through the optical fiber is obtained with respect to the reference measurement, for example ~~0.5...1~~ 0.5 to 1 dB.

Please replace the paragraph that begins on page 24, line 2 which begins "An alternative procedure for modifying an optical fiber" with the following amended paragraph:

An alternative procedure for modifying an optical fiber according to a second embodiment of the present invention is shown in **Fig.5** as a flow chart. Light is ~~in-coupled~~ coupled into the fiber core at the fiber entry, and the transmitted light power is measured at the fiber end. The coating is removed from the optical fiber at the position to be treated, and the uncovered fiber cladding is cleaned. The fiber cladding is treated by means of electric arcs at the uncovered position while the optical fiber maintains straightly aligned, so that a partial mixture of the materials of the core and the cladding is obtained at this position, and as a result a part of the light is not guided through the optical fiber any longer, but emanates the optical fiber. The intensity of the scattered light can be adjusted by controlling the parameters of the electric arcs (e.g. duration, repetition frequency), in that the power transmitted through the optical fiber is monitored and the electric arc treatment is continued until a desired damping is obtained. In this procedure severing and newly splicing together of the optical fiber is not necessary, whereby a reduction of time, an improved mechanical stability and a better reproducibility of the results are obtained.

Please replace the paragraph that begins on page 25, line 32 which begins "Subsequent to manufacturing, the power monitor" with the following amended paragraph:

Subsequent to manufacturing, the power monitor is calibrated once, and may then be integrated into a control loop, for example to control the light power ~~in-coupled~~ coupled from the light source into the optical fiber. **Fig.7** shows a calibration curve, in which the voltage signal U_{pd} measured by photodiode 306 is shown as a function of the light power P transmitted through the optical fiber 100.

Please replace the paragraph that begins on page 26, line 17 which begins "With respect to the prior art" with the following amended paragraph:

With respect to the prior art, the present invention is distinguished in that the power monitor according to the present invention can be manufactured simply and cheaply, comprises a compact and space saving design and a mechanically robust construction. In particular, the decoupling of scattered light out of the optical fiber is effected without a micro-bend of the optical fiber, thereby increasing the mechanical stability of the optical fiber. Therefore, the decoupling of the scattered light out of the optical fiber is not effected by a mechanical shift of the angle of total reflection with respect to the direction of the incident light as in a bending decoupler, but is effected by the partial insertion of scattering centers in the interface region between the core and the cladding of the optical fiber, whereby parts of the light are incident upon the cladding substantially perpendicularly directed and, thus, are transmitted through the cladding. The manufacturing does not require expensive equipment, as for example a vacuum pump station as it is used in ~~{13}~~ US 4,923,273. A commercially available splicing device may be used to apply the electric arcs.

Please delete the entire text of page 29 beginning at line 1 with "In this application the following publications are cited" and ending at line 21 with "[19] US 4 371 897".